

THE MODERN TREATMENT OF
C H O L E R A
UNDER ACTIVE SERVICE CONDITIONS,

BEING AN ACCOUNT OF AN OUTBREAK

- at -

T I B E R I A S
IN 1918.

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BY

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INTRODUCTION.

The Cholera outbreak at Tiberias on the Sea of Galilee in Oct., 1918, that I am about to describe was of great importance from a military point of view. Consequently, the author and a bacteriologist, (Capt. A. Compton, R.A.M.C., O.C. 32 Mobile Laboratory) were dispatched to the scene of the outbreak in order to investigate the conditions and, in short, to adopt any measures possible to suppress the epidemic.

The matter was of considerable urgency. Tiberias lay on the direct line of communication for troops operating in the Damascus area, and it was essential that all reinforcements and food supplies pass through the town.

The hilly nature of the country, the arid soil, the daily extremes of temperature at that season of the year - for the days were hot and the nights bitterly cold - the deficient and defective water supply - all these factors had a bearing upon the health of the troops and the

nature of the problem. Had Cholera spread at that critical period to any great extent it might have brought, what proved to be, one of the most brilliant feats in military history, to an untimely close.

CHAPTER I.

HISTORICAL AND GEOGRAPHICAL SURVEY OF THE COUNTRY.

The town of Tiberias is situated on the western shore of the Sea of Galilee. It has a population of three thousand five hundred, of which nearly two thousand are Jews, the remainder Christians and Mohammedans. The name "Tiberias" does not loom large in Biblical history, for it is mentioned once only, (i.e. John VI, 20), and there is no reason to believe this place was ever visited by Christ.

The town was built by Herod Antipas (A.D. 20), and was dedicated to the Emperor Tiberias. Its subsequent military history consists of capture and recapture successively by Arabs, Turks, and Crusaders.

The modern town occupies a very much smaller area than the ancient one, for the walls of the former Roman city can still be traced extending up the slope of the foothills to the West and South.

The first impression of Tiberias as seen from the main road is that of a peaceful, cleanly town hugging the lake shore. On closer

acquaintance this impression is soon dispelled. The streets are narrow and badly paved, and form the common rubbish heap and main sewer of the town. The houses are low with flat roofs, few windows, and no attempt at ventilation. The water supply is poor, derived chiefly from wells in the town, and these are polluted from surface contamination.

The majority of the population, however, draw their water from the Sea of Galilee, while the shores of the lake in the vicinity of the town are littered with human faeces. The appearance of the inhabitants reflects the nature of the insanitary surroundings; their quarters are poor, overcrowding is common, and they share their dwellings with their goats and fowls.

The Sea of Galilee itself played the chief part in the outbreak, therefore a few remarks on its geographical position and its history may not be out of place. The lake is pear-shaped, widening out towards the north; it is six and three quarter miles at its greatest width, and its extreme length is twelve and a quarter miles.

The river Jordan enters at the north end as a swift, muddy stream, which colours the water for fully a mile from its mouth; at the southern end the river emerges again as a clear limpid

stream. As is well known, the level of the lake is below that of the Sea, being six hundred and eighty feet below the Mediterranean. Violent storms still arise as in the days of the Apostles, due, it is said, to the low level of the lake and the great variations of temperature.

Many allusions to the Sea of Galilee are found in the Old Testament, (Numb. XXXIV, Deut. III, 17, Joshua XII, 3) where it is spoken of as the Sea of Chinneroth from a town of that name which stood on its margin.

In the New Testament, it is called the Sea of Galilee, or the Sea of Tiberias (John VI, 1), and the modern name is Bahr Tiberiyah. It was in these parts that Christ "performed many mighty works and spake many ~~mighty~~ things." Here He performed the miracle of the draught of fishes, (Luke V, 1-2). From a ship on the lake He discoursed to the multitude on the shore concerning the Kingdom of Heaven, and related the parable of the seed and the sower, and the parable of the grain of mustard seed. It was in this Sea that His ship was caught in a great storm, and He arose and rebuked the wind and the waves, and produced the wondrous calm.

The view of the lake and its surroundings, seen from the high ground is of rare beauty.

There is an indefinable atmosphere about this old-world place, originating partly in Christian teaching which leaves a profound impression on the traveller.

CHAPTER II.

THE CAMPAIGN IN PALESTINE AND ITS RELATION TO THE OUTBREAK.

The military importance of the cholera outbreak at Tiberias will be gathered from a brief outline of the strategy of the advance and its results. The appended sketch showing the British lines in red and the Turkish in black gives the situation at 2.0 A.M. on Sept. 19th. 1918. The Commander-in-Chief, General Sir Edmund Allenby, had formulated his plan of campaign with great care and forethought. He aimed at nothing less than the complete annihilation of the entire Turkish force in this region. Holding the eastern portion of his front with a skeleton force he yet succeeded in making the enemy believe that the main British attack would be launched here. Three divisions of cavalry, three of infantry, and all the available artillery, he concentrated on the coast above Jaffa. The three miles of enemy front nearest the coast were to be subjected to an intense barrage for two hours; then, on lifting the barrage, the infantry were to cut an opening for the cavalry. Once clear of the Turkish defences the country was open to an enveloping movement on

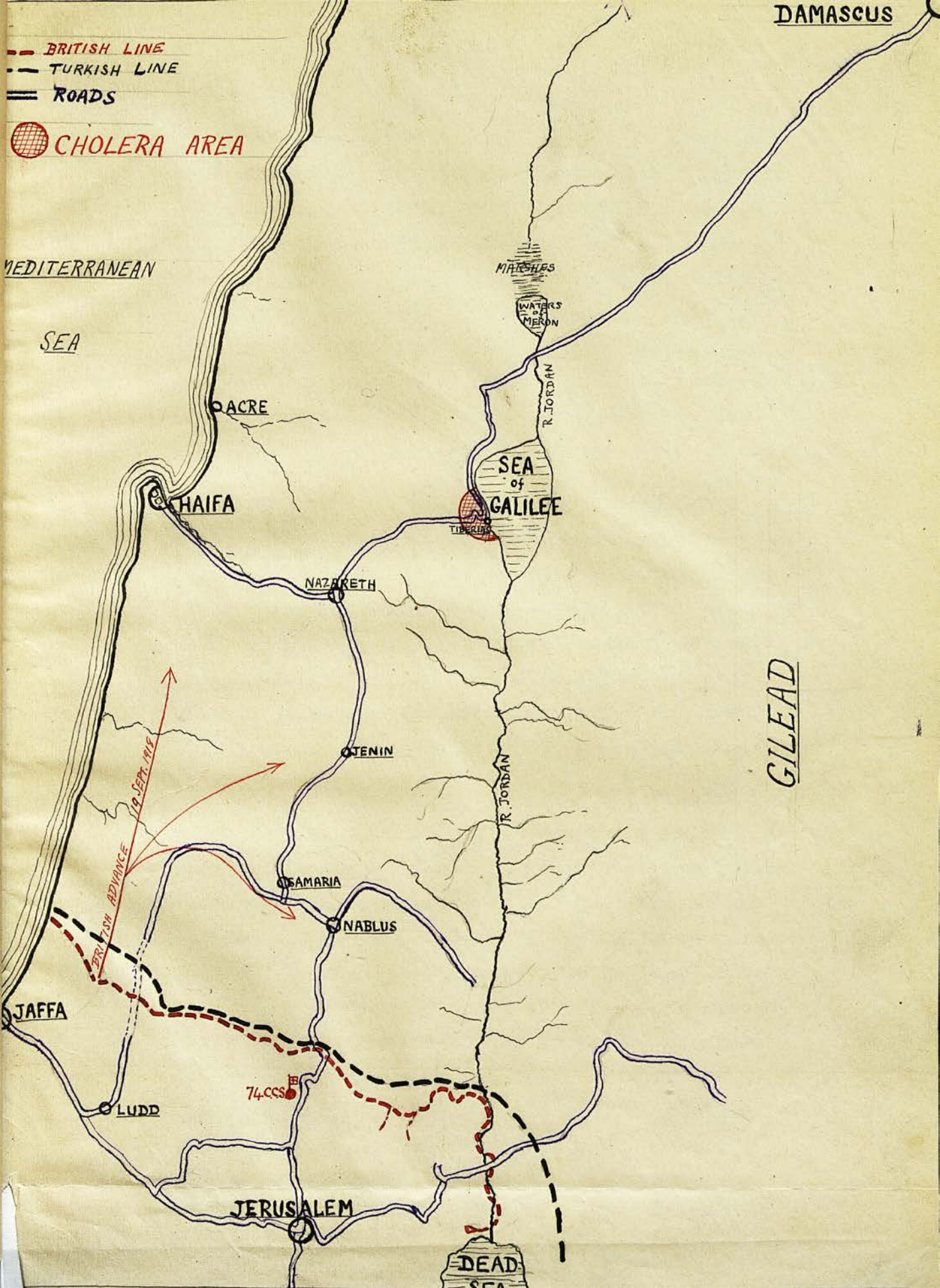
DAMASCUS

--- BRITISH LINE
--- TURKISH LINE
== ROADS

CHOLERA AREA

MEDITERRANEAN

SEA



GILEAD

DEAD SEA

a grand scale. The attack was admirably carried out according to plan. On Sept. 19th., at 2.0 A.M., the barrage commenced; at 4.0 A.M. the infantry advanced, and with scarce two hundred casualties completely cleared the way. By 6.0 A.M. our cavalry had passed through the gap and successfully carried out their part of the movement, advancing in the directions shown by the arrows on the map.

The brilliant success which attended the attack is a matter of history. The mighty Turkish line west of the Jordan was no more. Sixty thousand prisoners were taken, with all their artillery, and vast quantities of stores. A part of the Turkish reserve escaped, however, and had to retreat to Damascus, since the coast route was in our hands from Haifa to Beyrout.

East of the Jordan, we did not meet with such complete success, twenty thousand Turks escaping towards Damascus. Pursuit of the broken and retreating Turkish army was hampered by the destruction of the bridges on the Haifa-Damascus railway, so that the British advance must needs be by road via Nazareth and Tiberias to Damascus, where the destruction of the Turks was confidently anticipated. Hence the importance of the Damascus road and the untimely and inopportune appearance of cholera at Tiberias.

On Sept. 28th. information was received from the A.D.M.S. of the Australian Division that the natives of Tiberias were dying of cholera, or some disease closely resembling it.

This disturbing news gave rise to considerable anxiety for the health of the troops, and, realising the high infectivity of the disease and its heavy mortality, it was imperative that this outbreak, menacing our very line of march, should be crushed with the utmost dispatch.

Owing to the rapidity of the British advance, men and horses were compelled to maintain themselves on the country they were traversing. Now, Tiberias was the first town after Nazareth where food and water could be had in sufficient quantity for a large body of troops. Cleanliness is not an attribute of the Eastern natives and the conditions of life among the people of Tiberias were, to our mind, appalling. Food and water were generously exposed to cholera contamination, and in this connection we may recall the dictum of Ernest Hart, "You can eat cholera, you can drink cholera, but you cannot catch it."

The scarcity and the great need of suitable watering places made it clear to the Army Authorities that the troops would be infected if they were permitted to use Tiberias on their march; consequently the town was at once quarantined,

with a guard of three hundred men to enforce it. All units were halted outside the prohibited area and informed of the quarantine. If any delay was made in the infected area, or any food bought in passing through, those who infringed the regulations would be quarantined for two weeks. The only person who was quarantined was a military chaplain, who came on a sightseeing tour towards the close of the epidemic. He was duly informed of the quarantine and the penalty, but refused to take heed and insisted on exploring the town. In less than an hour, however, he was marched off to a quarantine camp, where, for a week in close confinement, it is hoped he pondered over the benefit of a civilized hygiene.

CHAPTER III.

DESCRIPTION OF THE OUTBREAK AND METHODS ADOPTED TO COMBAT IT.

On the morning of Sept. 3rd, our expedition set out from the 74th. Casualty Clearing Station en route for Tiberias. A two-ton motor lorry specially equipped for emergency bacteriological work constituted the 32nd. Mobile Laboratory.

We reached Nazareth at the end of the first day, passing through the scene of the late British advance. The terrain presented the usual picture of carnage and destruction, inseparable from operations on a grand scale - men, horses, guns and equipment of every description littered the ground, and at Jenin, wrecked aeroplanes and battered hangars.

Arriving at Nazareth - a surprisingly clean and well built town - we found the Australian C.C.S. established there; a church having already been converted into a hospital by them.

We hastened on and arrived at our destination - Tiberias - in the early afternoon of the second day. We sought out the Commandant,

explained our mission, and were forthwith installed in the house of Dr. Torrance, physician to the Medical Mission of the Church of Scotland. This was a building of eight rooms and Compton immediately proceeded to fit one up as a Laboratory. For my part, I set out on a tour of investigation in the town, and here I wish to express my gratitude to the Commandant for the ready and invaluable assistance rendered by him during our stay in the infected area.

My first duty was to see some of the cases of alleged cholera, and in this I was assisted by two native doctors - graduates of Beyrout. The varied clinical pictures (1) I saw that afternoon were so absolutely typical of the different stages of cholera that I felt convinced that if the disease was not cholera, it was so closely allied to it as to require the same treatment and preventive measures. Specimens of stools were taken and sent to the Laboratory for bacteriological investigation. The native doctors, who displayed a phlegmatic indifference to the epidemic, informed me, much to my surprise, that each year there was a visitation of cholera to Tiberias with a toll of deaths among the natives.

On consulting the literature on the subject, frequent mention is made of cholera outbreaks in Palestine and Syria (2). There seems little doubt that Lower Bengal (3) - the "Home of Cholera" - is the centre from which infection spreads to these countries. During the Indian epidemic of 1817-23 (4) occurs the first definitely traceable epidemic (1822) of cholera in Palestine and Syria. The infection was carried by troops to Muscati in Arabia, thence up the Persian Gulf to Basra, along the Tigris valley to Baghdad, and by caravan to Aleppo, and from there disseminated all over Syria and Palestine.

In 1831 the next epidemic occurred; brought from India to Mecca, it was spread amongst the thousands who were congregated there, and thus carried to Suez, Palestine, and Syria. Further outbreaks are recorded in 1853, 1865, 1883 and in 1903, and in each case the infection was shown to have emanated from Indian pilgrims to Mecca, and there disseminated broadcast over Egypt, Palestine, Syria and Persia.

The native doctors were probably correct in saying that people died each year of cholera in Tiberias, and, considering that from 1915

onwards there was no opportunity for infection along the secular route from Mecca, it is no mere presumption to hold that the disease was endemic on the shores of the Sea of Galilee.

My next duty was the inspection of the town water supply. Scattered throughout Tiberias were wells ideally situated for contamination from all sides - wells with privies, manure heaps and garbage of every description in disturbing proximity.

The Sea of Galilee, however, constituted the chief source of supply for the major portion of the population. The conditions on the lake shore were astounding; one popular 'collecting spot' was cunningly situated between two little piers on which were seats for defaecation. Thus, with true Eastern economy of effort might the need for gossip be satisfied, the calls of Nature observed, and domestic requirements attended to, all in one place. From a specimen of water collected at this spot Compton grew vibrios which showed perfect agglutination.

The problem was now unfolded, and, following a conference with the commandant,

the shore was patrolled night and day, and no one was permitted to draw water from the lake - a few volleys over their heads convinced even the most insistent natives that the lake-water was not good for them.

Next, all wells, obviously hopeless from a hygienic standpoint, were closed up, while others in better condition and less obviously contaminated, were taken over by the Commandant. A guard was posted at the wells, the men received instructions in the method of chlorination, and further, no one was allowed to draw water except at certain appointed times. Thus, only chlorinated water was available, and needless to add, did not suit the native palate, or increase our popularity.

Having then with considerable dispatch established the water supply on a tolerably satisfactory basis, our next concern was the dissemination among the townspeople of knowledge concerning cholera. This part of the work was delegated to the native doctors, and a carefully selected band of interpreters recruited from the town. The disease, the modes of infection, the general precautions and the great advantages of inoculation were sufficiently explained (5 & 6).

To their credit be it said, the natives were quick to take advantage of the vaccine, and at this opportune moment a Medical Officer of the occupied Enemy Territory Administration appeared on the scene bringing with him a large stock of Cholera Vaccine and Chloride of Lime in quantity.

He carried out the work of inoculation with the happy result that in ten days over two thousand of the inhabitants received injections of Cholera Vaccine.

CHAPTER IV.

PRELIMINARY PREPARATIONS FOR THE TREATMENT OF CASES.

I was now free to devote my whole attention to the actual treatment of the cases of cholera; my first aim was, naturally, the discovery of a building suitable for conversion into a hospital. Fortunately, there was available on the outskirts of the town an unoccupied house of two storeys, standing in an ample garden which contained a good well; the whole surrounded by a high stone wall.

With the Commandant's permission I entered into possession immediately. The building was in sad need of repair - most of the windows were broken, cobwebs abounded, and dust and refuse littered the floor. An energetic fatigue-party, however, rapidly effected a welcome transformation. The equipment and disposition of the rooms was my next consideration. Beds, trestles, bedding, blankets, cooking utensils, and receptacles of various kinds were acquired by the simple process of commandeering.

The available floor-space afforded by the house - two storeys and a basement - I disposed of in the following fashion:-

Basement - consisted of two cellars and was set aside as a Mortuary.

Ground Floor - four rooms and a kitchen at the back, the kitchen and the adjoining room I designated for the use of the staff, another room the "receiving ward", the remaining two were to be used as "observation wards".

First Floor - four rooms and a kitchen. The kitchen was set apart for cooking the patients' food, and for making saline solutions. In the four larger rooms, providing adequate accommodation for twenty patients, the definite cases of cholera were to be nursed. The remaining room, smaller than the others, I decided to use as a "saline room". Here, all intravenous injections of saline were given, and, by properly arranging three couches, I was able to supervise the simultaneous administration of saline to as many patients.

I had now to make provision for the nursing of the cases. Volunteers from the natives were called for. Amongst those who

presented themselves were two young women who had had some previous experience of nursing, (in a Jewish Hospital), and who fortunately had a fair acquaintance with English. The addition of three men and eight women, all ignorant of nursing, completed the staff. In their own interest I deemed it advisable that they should have some instruction in the nursing of cholera, and the method of obviating infection. With the help of the women who spoke English, I was able to impress upon the others the necessity of some simple precautions and in this connection it is satisfactory to note that none of the staff developed cholera.

The selection of the cases to be admitted was left in the hands of the two native doctors, supervised by the officer of the Occupied Enemy Territory Administration. It was fortunate that this was so, for the hospital would otherwise have been overwhelmed by swarms of people who sought treatment for the most varied conditions.

Many difficulties were encountered when the hospital began to function. The only disinfectant supplied in bulk by the Army Authorities was crude cresolis and this,

perforce, had to be used for the disinfection of stools.

The soiled clothes gave much trouble and were never dealt with to my satisfaction. The patients, owing to their poverty, had no spare linen, and had to lie in their filthy garments until changes were available. Then the soiled clothes were washed in cresolis solution and hung in the sun to dry; a method which proved effective owing to the intense heat (7 & 9).

The feeding problem was simplified by the ease with which large quantities of barley could be obtained. Barley water was the sole article of food I allowed the acute cases - a manifestation of hard-heartedness which my assistants neither understood nor forgave. Meat extracts and soups not being available, the diet in early convalescence was limited to milk, water, eggs and bread, articles easily obtainable locally.

Concerning the disposal of the dead, there is little to relate. By arrangement the commandant's staff supervised all burials. Bodies had to be interred within twelve hours of death in a special cemetery, six hundred yards from the town; if not by relatives, then by the military. This regulation was

most effective as both Mohammedans and Jews are careful that their dead are buried by co-religionists.

The medicinal treatment was very simple, and was carried out under my instructions by the two partly trained nurses. Depending on the stools, from two to four two-grain pills of Potassium Permanganate coated with Kaolin (1 & 8) were given every hour for the first day, and four pills every four hours for the next two days. When the stools became less copious and green, the Permanganate was gradually diminished, and ultimately omitted. Barley water was the only food given during the administration of Potassium Permanganate (1), and, despite the large doses used, I never saw any ill effects.

The "saline" treatment was undertaken entirely by myself. Six large kettles, each holding about eight pints, were filled with water, and boiled over Primus stoves, the requisite number of saline tablets were added and the solution left to cool. By doing this each evening, saline at any temperature was available next day, by simply

heating one of the kettles and mixing hot and cold saline in the required proportions.

Thus with a slender and oftimes crude equipment, I was enabled to carry out the "hypertonic saline" treatment of cholera (1), chiefly by means of the compact, yet complete, outfit devised by Rogers and supplied to the Army. It was in two parts, the emergency case and the reserve case.

The Emergency Case: This was a tin box 16" x 12" containing:-

1. Sterilizable Glass Bulb, capacity one pint with two ounce graduations from 0 to 20.

2. Camulae (sil^{ver}~~ent~~) with stop cocks.

4 Camulae (glass)

1 Instrument Tray with scalpel, forceps, dissecting and artery, aneurysm needle, ordinary needles.

Catgut in sterilized tubes.

Silk " " "

Rubber tubing.

100 tablets for Hypertonic Saline.

4 tablets (R/ NaCl gr. xxx CaCl gr. 1.

KCL gr. iss) to 1 pint.

100 Tablets for Normal Saline.

2 Thermometers (small).

1 Large " for Temperature of Saline

1 Metal Case with set of fifteen bottles
of Glycerine Solution of Specific
Gravity.

1044, and 1046 to 1072, with pipette
for testing of blood.

1 Sphygmomanometer modified Riva Rocci
for Blood Pressure.

100 Potassium Permanganate tablets gr. ii.

100 Pulv. Kino. Co. Tablets.

Atropine, Morphia, Strychnine and
Digitalis tablets for hypodermic use.

Compressed dressings.

The Reserve Case. This was a large box
weighing eighty pounds, containing triplicate
sets of the saline apparatus plus supplies
of tablets and dressings, and some of the more
common general medicines in tablet form.

CHAPTER V.

DESCRIPTION OF ROUTINE METHODS OF EXAMINATION AND TREATMENT.

The cases selected by the doctors for hospital treatment were given an admission order and brought to hospital. My routine was:-

I made a complete examination of each case in the Receiving Room. Patients with premonitory symptoms, (i.e., mild diarrhoea, vomiting, clammy skin and anxious expression) were removed to the observation wards, where I immediately proceeded to ascertain in each case the specific gravity of the blood, and the blood pressure. If there was no great abnormality in the specific gravity of the blood, (i.e., below 1060) and the blood pressure above 95 m.m. Hg., I treated them in an expectant manner by prescribing Pulv. Kino. Co., Potassium Permanganate Pills, and barley water to drink. The stools were then sent for bacteriological examination.

More advanced cases, (i.e., those with copious vomiting, profuse diarrhoea,

skin shrivelled, cramps and cyanosis) were transferred direct to the saline room, and there the specific gravity of the blood, blood pressure and rectal temperature taken.

Collapsed cases (with pulse imperceptible, voice a hoarse whisper, and the body dehydrated), were promptly conveyed to the saline room, and the same method adopted as in the previous class.

Other cases, which proved to be dysentery, infantile diarrhoea, malaria, etc., were not admitted.

The chief guide for intravenous saline was found in the specific gravity of the blood, indicating the stage of depletion of the blood serum through loss of fluid. The technique is simple and the operation quickly done. A few drops of the blood are taken in the pipette from the finger or the ear of the patient, and then ascertained in which glycerine solution the drop of blood remains suspended. If the specific gravity of the blood was over 1060, I deemed transfusion necessary. The blood pressure was taken by the Riva

Rocci Sphygmomanometer and invariably it was found, if the specific gravity of the blood was high, the blood pressure was low, (i.e., below 95 m.m. Hg.). The urinary output was of great value, but in new cases the history was always most unreliable.

Having decided transfusion was necessary, the rectal temperature was taken, as the guide to the temperature of the saline to be injected. Rogers has worked out that if the rectal temperature is below the normal, then the temperature of the saline must be raised above 100°F., and conversely if the rectal temperature is very high, then the saline temperature must be lowered accordingly. He holds, in subnormal rectal temperature, it helps in the collapsed stage by raising the temperature of the blood, and in high rectal temperatures by avoiding hyperpyrexia during the reaction stage. Where the rectal temperature was normal, the fluid was given at 100°F.

E.G.,	Rectal Temperature	100°F.	saline Temp.	94°F.
"	"	103°F.	"	" 84°F.
"	"	97°F.	"	" 104°F.

The technique of the injection is most simple. One of the veins at the elbow, the median cephalic, or median basilic was dissected out, the canula inserted and tied into the vein. I would here emphasize the necessity of cutting down on the vein and tying in the canula. The bitter experience I had in the first few cases in which I tried inserting the needle into the vein, convinced me of its futility, and that the only feasible method was to tie in a canula. The collapsed veins, the ignorance of my patients, and the restlessness common to all cholera cases made the above method imperative.

Further, the extra time necessary for tying in the canula is negligible, and the actual operation of no inconvenience to the patient. Where convenient I found it advantageous to give intravenous salines to two or three patients at the same time, being a saving of time and labour. My mode of procedure in giving three salines at once was, to cut down on the vein, tie in the canula, and set the saline running in the first case and so on to the second and third.

Having done so, it was time to estimate the specific gravity of the blood and blood pressure of the first patient, as I considered it necessary to take the specific gravity of the blood and blood pressure after each pint injected up to the third; after that more frequently.

The training of my assistants in this part of the work took some time. Each had their own little part of the operation to do; one assistant held the flask, another held the patient's arm, while a third filled the flask as required. One of the partly trained assistants helped me in inserting the canulae, and regulated the temperature of the saline. The whole scheme worked extremely well.

The rate of flow of the saline was a pint every five minutes up to three pints, subject to the specific gravity of the blood, and the blood pressure, and also the condition of the patient. The rate of flow above three pints varied in each case, but from one to two ounces per minute was the average.

In the event of any contra-indications, such as pulmonary embarrassment or severe headache, the flow was slowed down to one ounce per minute, and if the untoward symptoms still persisted the injection was discontinued.

The quantity injected depended upon the specific gravity of the blood and blood pressure. In all straightforward cases, the specific gravity of the blood was lowered to 1050, and the blood pressure raised to 110-115 m.m. Hg. In many cases I found the latter most difficult to accomplish. The specific gravity would record 1050, while the blood pressure would only be 95 m.m. Hg.; therefore, in these cases, I considered it unsafe to push the saline further. The amount of saline required to bring the specific gravity of the blood and blood pressure within normal limits depended upon the state of collapse, but, in the majority of cases, it was from two and a half to four pints.

What was to be done with the early convalescents? It was neither admissible nor advisable to fill my cholera beds with

them. I endeavoured without success to procure a hospital marquee from the army for the purpose; fortunately the American Red Cross at Jerusalem came to my aid, and a marquee was erected in the garden, where cases were transferred until ready for discharge.

The two great features which decided a patient's fitness for discharge were:-

1. Stools clear of vibrios.
2. The general condition of the patient's health.

The average stay in hospital was from eight to ten days; by then, the stools were clear and they were fit to be nursed back to health by their friends at home. In no case were vibrios found in the stools after two weeks, and many were clear in three to five days.

LABORATORY EXAMINATION.

The following was the routine carried out by Compton in the examination of the stools. On arrival of the specimen, which was usually of a rice-water appearance, a good-sized platinum loopful was inoculated into a tube of alkaline peptone water and transferred to the incubator at 37°C for a few hours. Then a Petri dish of Endo's medium was inoculated from the peptone water dilution, and incubated over night.

Next morning, the growth in the Petri dish was examined for cholera vibrios, which as regards cultural appearances, show up on Endo's medium at first, as those of a typical non-lactose fermentor, and later, as colonies with faint pink centres and colourless translucent borders - an appearance which is quite characteristic. Any such colonies found were immediately examined microscopically from the point of view of motility and vibrio morphology; and to prove conclusively that they were the true, (and not the pseudo-) vibrio of Koch, a rapid agglutination test by the Alcock-Garrow slide method was carried out. Thus

sufficient evidence was available for a laboratory report being furnished well within twenty-four hours from reception. Invariably, however, at this stage, confirmatory cultural tests were performed by inoculating some of the pure culture into McConkey's lactose - litmus - liquid medium (acid, but no gas production), peptone water, (indol production) and also into each of the following sugars; glucose, maltose, saccharose, mannite, and dulcite, (acid production in all except dulcite); the results of these confirmatory tests were read off twenty-four hours after inoculation.

CHAPTER VI.

DESCRIPTION OF CASES.

Although cholera presents great variations in degree of severity, there is probably no acute infection which shows greater constancy in its principal manifestations. In describing the cases it is necessary to divide them into three groups:-

- I. The Premonitory Diarrhoea Group.
- II. The Acute Group.
- III. The Algid Group.

These, however, naturally shade off into each other. I treated in all fifty-one cases.

Group I. 11 cases.

Group II. 25 cases.

Group III. 15 cases.

PREMONITORY DIARRHOEA GROUP.

Though many cases of cholera never pass through this stage, but suddenly develop acute symptoms, it is important, that, when present, it should be recognised, to permit suitable treatment being instituted, and so prevent grave symptoms supervening.

The two following cases represent the type:-

CASE 21 Man, age 34, diarrhoea for one day, with vomiting and shivering, stools bile-stained. The specific gravity of the blood was 1059, the blood pressure 92 m.m. Hg., urine scanty, stools contained bile and recognisable faeces. No collapse, not transfused. Pulv. Kino. Co. grs. xx, Potass. Permanganate Pills, grs. iv, 6 hrly. given and barley-water to drink. Next day the specific gravity of the blood was 1056, urine 30 ozs., blood pressure, 100 m.m. Hg., stools less frequent and patient much improved. Cholera vibrios were present in the stools. Uninterrupted recovery and discharged on the 7th. day.

CASE 44 Girl age 18, diarrhoea for two days, copious bile-coloured stools, not collapsed. Specific gravity of the blood 1060, blood pressure 88 m.m. Hg., history of urine passed.

Treatment:- Pulv. Kino. Co. and Potass. Permanganate Pills given, barley-water to drink. Next day diarrhoea still present, specific gravity of the blood 1059, and blood pressure 90 m.m. Hg. The following day, the diarrhoea persisted, the specific gravity of the blood 1060, blood pressure 96 m.m. Hg., no urine passed for twelve hours, transfusion of two and a half pints of

saline, reducing the specific gravity of the blood to 1050 and raising the blood pressure to 105 m.m. Hg. Urine passed freely, uninterrupted recovery and discharged on the 11th. day. On admission vibrios present in the stools in large numbers.

The foregoing group impressed upon me the necessity of, even in very mild cases, testing the specific gravity of the blood and the blood pressure as being the only reliable indications for transfusion. Case 44 is specially selected to show what great help this test may be in obviating suppression of urine.

THE ACUTE GROUP.

This group comprised the greater number of cases, twenty-five in all, and they presented the classical signs and symptoms of cholera. The three following cases may be taken as typical:-

CASE 5 Woman, age 35, admitted with copious vomiting and profuse diarrhoea with rice-water stools. The patient was evacuating pints of fluid, the skin cold and clammy, eyes sunken, cramps in legs and abdomen, anxious expression and very restless. The specific gravity of the blood 1066, blood pressure 80 m.m. Hg., urine nil. and rectal temperature 99° F. She was transfused with three pints of saline at a temperature

of 100°F. lowering the specific gravity of the blood to 1054, the blood pressure being raised to 100 m.m. Hg. The cramps disappeared and the patient was comfortable. Potassium Permanganate pills, grs. iv. given every hour for twelve hours, and two hourly afterwards for twenty-four hours. The following day the specific gravity was 1058, blood pressure 98 m.m. Hg., urine 15 ozs., diarrhoea much less, stools green in colour. On bacteriological examination many vibrios were present. Uninterrupted recovery and discharged on the ninth day.

CASE 9 Boy, age 19, admitted with diarrhoea and vomiting of four hours' duration, cheeks and eyes sunken, nose pinched and thin, muscular cramps in legs, very restless and pulse thready and weak. The specific gravity of the blood was 1067, blood pressure 78 m.m. Hg., rectal temperature 102°F. He was transfused with three and a half pints of saline at 92°F., reducing the specific gravity of the blood to 1050, the blood pressure being raised to 105 m.m. Hg. He had a rigor one hour after transfusion, temperature 104°F. sponged down to 101°F. Potassium Permanganate pills grs. iv. given hourly for twelve hours and barley-water ad. lib. to drink.

Next day, urine 20 ozs. passed, specific gravity of the blood 1055, blood pressure 96 m.m. Hg., diarrhoea improved, stools green in colour. Laboratory report:- cholera vibrios in large numbers. The fourth day he passed 50 ozs. of urine, made a quick recovery and was discharged on the ninth day.

CASE 42, Corporal J.S. Australian Light Horse, age 30, a well-built healthy man. He reported sick at 9 a.m., and complained of discomfort in his abdomen and diarrhoea during the night. The stools were loose and contained bile and faeces, history of passing urine during the night. I ordered him to bed and prescribed Pulv. Kino. Co. grs. xx, Pot. Permanganate grs. iv. and no food except barley water. At two a.m. - five hours later - the diarrhoea was more profuse, very little bile in his stools and great discomfort in his abdomen, some vomiting, skin rather cold and clammy. I sent him to hospital, and at 3 p.m., the symptoms were more marked, and although no collapse, the specific gravity of the blood registered 1070, blood pressure 90 m.m. Hg., and rectal temperature 98° F. The specific gravity being high, I recognised his condition to be grave, and transfused him forth-

with, giving him four pints at 100° F. The specific gravity lowered to 1056, blood pressure raised to 115 m.m. Hg., the vomiting and diarrhoea stopped; he was comfortable. At 6 p.m. his temperature rose to 106° F. with profuse perspiration; he passed 20 ozs. urine. He was sponged down to 103° F. but within half-an-hour the temperature was again 105° F. The specific gravity of the blood and blood pressure showed 1058 and 100 m.m. Hg., respectively, and I could find no indication for a second transfusion. He became delirious and unconscious, further attempts to reduce his temperature were futile and he died at 11 p.m. with a temperature of 106° F. The bacteriologist reported that the stools contained numerous vibrios.

THE ALGID GROUP.

In this group I had altogether fifteen cases and the three following represent the variations in this class.

CASE 2 Man, age 56, admitted pulseless, with history of severe diarrhoea and vomiting for twelve hours. Skin shrivelled, fingers cyanosed, eyes sunken, and he was very restless. The

specific gravity of the blood was 1072, blood pressure not recorded by the Sphygmomanometer, rectal temperature 103°F. Transfused with four pints of saline at temperature of 86°F. Injection was very slow, owing to pulsating headache as the circulation returned and discomfort in the chest. The specific gravity of the blood was lowered to 1058 only, owing to the impossibility of raising the blood pressure above 90 m.m.Hg. - Pot. Permanganate grs. iv. hourly, and barley-water to drink. Next day he had recovered from his collapse, but no urine passed, the specific gravity of the blood was 1059 and the blood pressure only 84 m.m. Hg. I transfused him a second time, but failed to raise the blood pressure over 90 m.m. Hg., and he died on the evening of the third day, from complete suppression of urine. Bacteriologist reported numerous vibrios present.

CASE 13 Man, age 25, diarrhoea for 24 hours, admitted almost pulseless, skin cold and shrivelled, eyes sunken and anxious-looking, voice a hoarse whisper, and he was writhing with cramps in his abdomen. No urine passed for twelve hours. The specific gravity of the blood was 1070, the blood pressure too low to record, the rectal temperature 101°F. He was transfused with five pints of saline at 98°F. The pulse gradually returned, the

cramps gradually disappeared as the specific gravity of the blood came down to 1050, and the blood pressure recorded 105 m.m. Hg. Potassium Permanganate grs. iv. hourly for twelve hours, and two hourly for the following twenty-four. One hour after injection, he had a rigor, temperature 103° F., and was sponged down to 100° F. The following day the specific gravity of the blood was 1058, and the blood pressure was 100 m.m. Hg., urine 20 ozs. Laboratory report was - stools contained a large number of vibrios. The next day he passed 50 ozs. urine, and was very comfortable. He made a rapid recovery and was discharged on the eleventh day.

CASE 17 Man, age 68, very feeble, with history of diarrhoea and vomiting for twenty hours, skin cold and shrivelled, eyes sunken, fingers cyanosed, pulse rapid and very soft, cramps in abdomen and very restless. The specific gravity of the blood was 1068, the blood pressure 76 m.m. Hg., the rectal temperature 99° F. Transfused with saline at 98° F. but the injection was stopped after two and a half pints owing to great distress in the chest with rapid respirations. The specific gravity of the blood recorded 1060, the blood pressure 84 m.m. Hg. Twelve hours later, the specific gravity of the blood was 1062, and the blood pressure 80 m.m. Hg.; 50 ozs. of urine passed.

A second injection was given, but again after two pints the transfusion was stopped owing to respiratory and circulatory embarrassment. On the third day 20 ozs. of urine were passed, pulse weak, blood pressure 88 m.m. Hg., and specific gravity of the blood 1058. Cardiac tonics, digitalis, strychnine and atropine were given, but were of no avail, and he died the same day.

The acute and algid groups demonstrate the necessity for prompt treatment with hypertonic saline, and also the fact that no case is too far gone for transfusion. Number thirteen was a case in point. I had invited one of the native doctors to come and see the transfusion. Standing quietly by during the operation, he witnessed the almost magical transformation of a pallid, shrivelled, writhing patient, into a man of good colour, firm pulse, normal respirations, lying comfortably on the couch. Just as I finished the injection, the native doctor with a dramatic flourish of his hands, ejaculated, "très magnifique."

COMPLICATIONS AND SEQUELAE.

The complications which I learned to fear most were:- Hyperpyrexia and Uraemia, both of which were responsible for the deaths of a number of cases.

Hyperpyrexia. In cholera, it is well known that the temperature is masked during the collapse period by failure of the circulation through the peripheral parts. When the circulation is restored, an excessive quantity of toxin is absorbed, and pyrexia, it may be hyperpyrexia, follows. If the temperature remains raised for a short time only, (one to one and a half hours), the danger is not great, but if it remains over 103°F. in spite of attempts to reduce it with the patient delirious or unconscious, then the prognosis is grave, and especially so in Europeans. Case 42, that of Corporal J.S., demonstrates this very well, and I find from statistics compiled by Rogers during a period between 1895 and 1906 in the European Hospital, Calcutta, that during the years under review, every patient whose temperature was over 103°F. died in the stage of reaction.

To prevent Hyperpyrexia, Rogers advocated that the temperature of the saline given intravenously should vary inversely with the rectal temperature; I endeavoured to carry this out, but in spite of my best efforts, I had certain fatalities.

Uraemia. The cases which suffered most from suppression of urine, partial or complete, were those who had been ill for twenty-four hours before admission, where stasis of the renal circulation had already supervened. Uraemia in cholera patients differs little from uraemia following other diseases, except that it is more rapidly fatal.

The relation of uraemia to blood pressure has also been investigated by Rogers. His conclusions are, that if the blood pressure is below 100 m.m. Hg. (in adult males), from two to three days after the collapse stage, uraemia is invariable; if raised to 105 m.m. Hg., no uraemia, if permanently below 100 m.m. Hg., all died. Therefore my axiom was:- to raise the blood pressure over 100 m.m. Hg. as soon as possible in all cases. This, however, was difficult to attain.

The specific gravity would register 1,050, while the blood pressure would still be 90-95 m.m. Hg.; in these cases I felt I could not continue the injection with safety. On the one hand I had the fear of uraemia later, on the other, I was afraid of causing sudden death from oedema of the lungs and collapse of the circulation, consequently I chose the less dramatic course of the two, and was guided solely by the specific gravity of the blood.

Sequelae. I had few other complications or sequelae, two cases of pneumonia, one of parotitis with abscess, and two cases of arthritis; none of these were fatal. The hurried and makeshift arrangements I had made for the treatment of cholera, served well for the intravenous saline treatment. To cope with the complications is another matter, and for this, a good hospital and adequate nursing appeared to be essential.

PATHOLOGY.

The findings in the few post-mortems I did were fairly uniform. Rigor mortis was usually very well marked, the tissues very dry and no free fluid in pleural or peritoneal cavities. The right side of the heart and the systemic veins were full of thick dark blood; the gall bladder full and often very distended with bile, and the spleen small. The surface of the bowel was of a diffuse bright red appearance. On opening the gut it contained rice-water, flaky material and streaks of blood. The mucous membrane of the stomach and intestine was bright red with small petechial haemorrhages into the mucous coat, but no definite ulceration on naked eye inspection. The ileum and jejunum were the parts chiefly affected, and the Peyer's patches were specially affected. The kidneys showed marked distension of the superficial veins with congestion of the medulla and cortex, and in the uraemic cases small cortical haemorrhages were common. It has been suggested that the haemorrhages and swelling of the kidney make the capsule so tense that in these cases the renal flow is definitely obstructed and may result in complete suppression of urine.

MORTALITY.

Out of fifty-one cases, I had twenty-nine recoveries, and twenty-two deaths, giving me a death-rate of 43.1%. During epidemics of cholera, it is recognised that the death-rate is very high at the commencement; this was particularly so in this outbreak, as six out of the first nine cases died.

My mortality is very high compared with the figure quoted by Rogers of his cases - having the same hypertonic saline treatment - in India from 1909-10, which was 23.3%. The prognosis in cases over forty years of age is always grave. A large number of my patients were over forty; twenty-three in all; and eight of these were over sixty; many of the former, and all the latter, died.

From these facts I derive considerable comfort, and had I been fortunate enough to have fewer cases of advanced years, I feel confident my death-rate would have been approximately 30%.

CONCLUSION.

The last case was admitted to hospital on the 20th. Oct. Thus, within three weeks had our efforts culminated in the crushing of the outbreak at Tiberias. Preventive measures, and an infusion of Western hygiene had triumphed. The danger to our army was removed - but one soldier contracted cholera, and he unfortunately succumbed.

Fairly, I think, may the success attained be attributed to the measures adopted, - the plan of campaign once decided on was rigidly adhered to. The isolation of the town, the closing of the bad wells, the disinfection of the available water, the vaccination of the natives, the removal of the sick, the prompt burial of the dead - all conspired in a greater or less degree to the happy result.

To the commandant much praise is due; he had the regulations concerning the water supply and the quarantine meticulously observed, and in every way possible to him, facilitated our work.

The assistance of the officer of the Occupied Enemy Territory Administration proved invaluable; the inoculation I hold responsible in great measure for our success. In this connection, too, one may note the surprising alacrity

of the natives to avail themselves of the protection afforded by the cholera vaccine, though to many of them it must have savoured of magic.

The work of recent years has, it would seem, abundantly shown wherein lies the real danger of cholera to the patient. On the one hand, we must combat the toxæmia, and on the other, make good the loss of a large part of the body fluids.

The destruction and neutralization of the bacilli and their toxins is an indication which may be met, in some degree, by the use of Potassium Permanganate, a non-toxic antiseptic belonging to the group of oxidizers.

The loss of the fluids indicates the intravenous exhibition of hypertonic saline solution, which not only replaces the lost fluid, but by raising the osmotic pressure of the blood, antagonises the intestinal hydrorrhoea induced by the cholera organisms. It was the considered opinion of Rogers, that this ideal treatment - eminently feasible in a well-appointed hospital in peace time - would in the stress of war become utterly impossible (10).

But even Homer nods. As to the conditions under which the Tiberias epidemic took place, there is little room for doubt, and though we

we entered on our duties with considerable misgivings, the outcome left us satisfied that a more hopeful spirit should replace the undue pessimism of Sir Leonard Rogers.

THE END.

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